What is claimed is:

1. A method for carrier tracking and spread spectrum code tracking in a spread spectrum communication system, the method comprising the steps of,

receiving a spread spectrum input signal having inphase and quadrature components communicating a spread spectrum code modulating a carrier,

carrier generating quadrature demodulation signals referenced to a local reference, the quadrature demodulation signals having a carrier phase referenced to the carrier,

demodulating the spread spectrum input signal by the quadrature demodulation signals for generating the inphase and quadrature components,

code generating early and late code replicas of the spread spectrum code, the early and late code replicas having a code phase referenced to the spread spectrum code,

correlating the inphase and quadrature components by the early and late code replicas for generating early and late inphase and quadrature correlation signals,

residual generating a residual from the early and late inphase an quadrature correlation signals and from a code phase error state and a amplitude state and a carrier phase error state and frequency error state,

calculating a code phase error and an amplitude and a carrier phase error and a carrier frequency error from the residual and a state error covariance matrix and the code phase error state and the amplitude state and the carrier phase error state and the frequency error state,

1   propagating the code phase error state and the amplitude

2 state and the carrier phase error state and the carrier

3 frequency error state from the code phase error and the

4 amplitude and the carrier phase error and the carrier frequency

5 error,

6   Riccati estimating the state error covariance matrix from

7 the code phase error state and the amplitude state,

8   carrier phase adjusting the quadrature demodulation

9 signals by the carrier phase error for reducing the carrier

10 phase between the carrier and the quadrature demodulation

11 signals for tracking the carrier, and

12   code phase adjusting the early and late code replicas by

13 the code phase error for reducing the code phase between the

14 spread spectrum code and early and late code replicas for

15 tracking the spread spectrum code.

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18 2. The method of claim 1 wherein,

19   the state error covariance matrix is a Riccati state error

20 covariance matrix P defined by an algebraic Riccati equation of

21 the form $0=AP+P^{T}A+W-Ph^{T}V^{-1}hP$ where A is a state dynamics matrix,

22 V^{-1} is an inverse observation covariance, h is a linearized

23 observation matrix, h^{T} is a transposed linearized observation

24 matrix, and W is a state covariance.

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27 3. The method of claim 1 wherein the communication system is a

28 GPS receiver and the code phase error is a range error.

4. The method of claim 1 wherein,

the spread spectrum input signal is a GPS spread spectrum signal,

the local reference is a local oscillator for coherent demodulation of the spread spectrum input signal, and

the spread spectrum code is a direct sequence spread spectrum code.

5. The method of claim 1 wherein the code phase error state and the amplitude state are assigned constant nominal values during the estimating step.

6. The method of claim 1 further comprising the steps of,

transmitter calculating a transmitter position and a transmitter velocity from the spread spectrum input signals,

receiver calculating a receiver position and a receiver velocity from the early and late inphase and quadrature correlation signals,

range calculating a range and a range rate from the transmitter and receiver positions and velocities, the range rate further adjusting the quadrature demodulation signals for reducing the carrier phase between the carrier and the quadrature demodulation signals for tracking the carrier, the range further adjusting the early and late code replicas for reducing the code phase between the spread spectrum code and early and late code replicas for tracking the spread spectrum code.

7. The method of claim 1 wherein,

the calculating step further calculates a carrier frequency rate error,

the propagating step further propagates a carrier frequency rate error state, and

the residual generating step generates the residual from the early and late inphase quadrature correlation signals and from the code phase error state and the amplitude state and the carrier phase error state and the carrier frequency error state.

8. The method of claim 1 wherein the residual generating step and the calculating step and the propagating step and the Riccati estimating step are a Kalman prefiltering process in a spread spectrum receiver in the spread spectrum communication system.

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9. A method for carrier tracking and spread spectrum code tracking in a GPS navigation processor in a GPS spread spectrum receiver, the method comprising the steps of,

receiving the GPS spread spectrum input signal having inphase and quadrature components communicating a spread spectrum code modulating a carrier,

carrier generating quadrature demodulation signals referenced to a local reference, the quadrature demodulation signals having a carrier phase referenced to the carrier,

demodulating the GPS spread spectrum input signal by the quadrature demodulation signals for generating the inphase and quadrature components,

code generating early and late code replicas of the spread spectrum code, the early and late code replicas having a code phase referenced to the spread spectrum code,

correlating the inphase and quadrature components by the early and late code replicas for generating early and late inphase and quadrature correlation signals,

residual generating a residual from the early and late inphase an quadrature correlation signals and from a code phase error state and a amplitude state and a carrier phase error state and frequency error state,

calculating a code phase error and an amplitude and a carrier phase error and a carrier frequency error from the residual and a state error covariance matrix and the code phase error state and the amplitude state and the carrier phase error state and the frequency error state,

1   propagating the code phase error state and the amplitude

2 state and the carrier phase error state and the carrier

3 frequency error state from the code phase error and the

4 amplitude and the carrier phase error and the carrier frequency

5 error,

6   Riccati estimating the state error covariance matrix from

7 the code phase error state and the amplitude state,

8   navigation calculating a receiver position and a receiver

9 velocity from the early and late inphase and quadrature

10 correlation signals,

11   satellite calculating a satellite position and a satellite

12 velocity from the GPS spread spectrum input signal,

13   range calculating a pseudorange and a pseudorange rate

14 from the receiver and satellite positions and velocities,

15   carrier phase adjusting the quadrature demodulation

16 signals from the pseudorange rate and by the carrier phase

17 error for reducing the carrier phase between the carrier and

18 the quadrature demodulation signals for tracking the carrier,

19 and

20   code phase adjusting the early and late code replicas from

21 the pseudorange and by the code phase error for reducing the

22 code phase between the spread spectrum code and early and late

23 code replicas for tracking the spread spectrum code.

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10. The method of claim 9 wherein,

the navigation calculating step further calculates clock

error estimates, and

the range calculating step calculates the pseudorange and

the pseudorange rate from the receiver and satellite positions

and velocities and from the clock error estimates.

11. The method of claim 9 wherein the residual generating step

and the calculating step and the propagating step and the

Riccati estimating step are a Kalman prefiltering process in

the GPS spread spectrum receiver.

12. The method of claim 9 wherein,

the state error covariance matrix is a Riccati state error

covariance matrix P defined by an algebraic Riccati equation of

the form $0 = AP + P^T A + W - Ph^T V^{-1} hP$ where A is a state dynamics matrix,

V^{-1} is an inverse observation covariance, h is a linearized

observation matrix, h^T is a transposed linearized observation

matrix, and W is a state covariance.

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1 13. A method for carrier tracking and spread spectrum code

2 tracking in an inertial GPS navigation processor in a GPS

3 spread spectrum receiver receiving inertial measurement

4 samples, the method comprising the steps of,

5   receiving the GPS spread spectrum input signal having

6 inphase and quadrature components communicating a spread

7 spectrum code modulating a carrier,

8   carrier generating quadrature demodulation signals

9 referenced to a local reference, the quadrature demodulation

10 signals having a carrier phase referenced to the carrier,

11   demodulating the GPS spread spectrum input signal by the

12 quadrature demodulation signals for generating the inphase and

13 quadrature components,

14   code generating early and late code replicas of the spread

15 spectrum code, the early and late code replicas having a code

16 phase referenced to the spread spectrum code,

17   correlating the inphase and quadrature components by the

18 early and late code replicas for generating early and late

19 inphase and quadrature correlation signals,

20   residual generating a residual from the early and late

21 inphase an quadrature correlation signals and from a code phase

22 error state and a amplitude state and a carrier phase error

23 state and frequency error state,

24   calculating a code phase error and an amplitude and a

25 carrier phase error and a carrier frequency error from the

26 residual and a state error covariance matrix and the code phase

27 error state and the amplitude state and the carrier phase error

28 state and the frequency error state,

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1 propagating the code phase error state and the amplitude

2 state and the carrier phase error state and the carrier

3 frequency error state from the code phase error and the

4 amplitude and the carrier phase error and the carrier frequency

5 error,

6 Riccati estimating the state error covariance matrix from

7 the code phase error state and the amplitude state,

8 integrating the amplitude and the code phase error and the

9 carrier phase error and the carrier frequency error and the

10 state error covariance matrix for providing an error state

11 vector,

12 navigation calculating a receiver position and a receiver

13 velocity from the error state vector and from the inertial

14 measurement samples,

15 satellite calculating a satellite position and a satellite

16 velocity from the GPS spread spectrum input signal,

17 range calculating a pseudorange and a pseudorange rate

18 from the receiver and satellite positions and velocities,

19 carrier phase adjusting the quadrature demodulation

20 signals from the pseudorange rate for reducing the carrier

21 phase between the carrier and the quadrature demodulation

22 signals for tracking the carrier, and

23 code phase adjusting the early and late code replicas from

24 the pseudorange for reducing the code phase between the spread

25 spectrum code and early and late code replicas for tracking the

26 spread spectrum code.

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14. The method of claim 13 wherein,

the integrating step further provides clock error

estimates, and

the range calculating step calculates the pseudorange and

the pseudorange rate from the receiver and satellite positions

and velocities and from the clock error estimates.

15. The method of claim 13 wherein the residual generating step

and the calculating step and the propagating step and the

Riccati estimating step are a Kalman prefiltering process in

the GPS spread spectrum receiver.

16. The method of claim 13 wherein,

the state error covariance matrix is a Riccati state error

covariance matrix P defined by an algebraic Riccati equation of

the form $0 = AP + P^T A + W - Ph^T V^{-1} hP$ where A is a state dynamics matrix,

V^{-1} is an inverse observation covariance, h is a linearized

observation matrix, h^T is a transposed linearized observation

matrix, and W is a state covariance.

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